

April 23, 2002

MEMORANDUM

SUBJECT: **ATRAZINE.** Review of Probabilistic Exposure Assessment for Drinking Water from 28 Community Water Systems. DP Barcode: 278468. PC Code: 080803. Case No. 0062.

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**BACKGROUND**

This memorandum summarizes the results of Syngenta's probabilistic assessment of exposure to chlorotriazines in 28 community water systems (CWS). The results of the assessments will be included in the final human health risk assessment for atrazine. Chlorotriazine residues include: atrazine, *per se*, and the three chlorinated metabolites of atrazine (desethyl atrazine, desisopropyl atrazine, and diaminochlorotriazine or DACT).

Previously, HED determined that intermediate-term exposure (30 days to 6 months) to chlorotriazines in drinking water occurring during late Spring and early Summer was the only exposure pathway and scenario of concern. All other drinking water and food exposure scenarios analyzed using a deterministic approach resulted in risk estimates that were below HED's levels of concern. HED's Revised Preliminary Human Health Risk Assessment for atrazine (dated 1/19/2001) identified 24 CWS using surface water with seasonal chlorotriazine residues exceeding levels of concern for infants and children. These 24 CWS were identified using a deterministic approach based on monitoring data collected across a variety of databases: compliance monitoring collected under the Safe Drinking Water Act (SDWA), and data

collected under two monitoring programs sponsored by registrants (the Voluntary Monitoring Program and the Acetochlor Registration Partnership). Consequently, HED concluded that refined estimates of risk for these 24 CWS should be estimated using all of the available data in a probabilistic assessment.

In response to HED's revised preliminary risk assessment, the registrant (Syngenta) has provided a probabilistic exposure assessment for aggregate exposures to chlorotriazine residues in food and the drinking water of 28 CWS. Of these 28 CWS, 24 were identified in the HED risk assessment document as having average seasonal concentrations over a 90-day period of chlorotriazine residues in drinking water above HED's levels of concern for infants and children.

In addition, the registrant also provided a comparison of the results of probabilistic exposure assessments using two different aggregate exposure models, DISTGEN™ and CALENDEX™. Exposures to chlorotriazine residues in food and drinking water in 5 of the 28 CWS were assessed with each model using the same and different methodologies. A comparison of the results was provided.

Although Syngenta conducted probabilistic assessments for 1-day, short-term, intermediate-term, and chronic exposures, HED has focused only on the results of the submitted intermediate-term probabilistic exposure assessment. Risk estimates associated with intermediate-term exposure to chlorotriazine residues in food and drinking water are presented as a percentage of a population adjusted dose (PAD). Risk estimates greater than 100% of the PAD exceed HED's level of concern. To estimate the risk associated with the 28 CWS assessed, HED has taken the results of the intermediate-term probabilistic exposure assessment conducted by Syngenta, and compared the resultant distribution of exposures to the PAD for intermediate-term effects.

The PAD for intermediate-term effects of chlorotriazine residues is 0.0018 mg/kg/day, and was selected by HED's Hazard Identification Assessment Review Committee (HIARC 12/20/00). It is based on attenuation of the pre-ovulatory lutenizing hormone (LH) surge in rats considered to be a biomarker indicative of atrazine's ability to alter hypothalamic-pituitary function in general. Alteration of the hypothalamic-pituitary function as evidenced through the attenuation of the LH surge was dose-dependent and first observed between 4 to 5 months of daily dosing in a 6 month study, making this endpoint an appropriate endpoint to assess intermediate-term (30 days to several months) and chronic (several months to lifetime) exposures to atrazine. Although this specific effect (attenuation of the LH surge) is operative in females, it was selected as the basis for chronic risk assessment for all population subgroups, because it is the most sensitive endpoint available from the toxicity database and therefore protective of other adverse effects, and it is indicative of alterations of the hypothalamic/pituitary/gonadal axis, which may occur in the offspring and adults of other species (humans).

## CONCLUSIONS

1. For the CWS assessed, the dominant exposure pathway for chlorotriazine residues is drinking water. Food exposures to chlorotriazines are insignificant (< 1% of the PAD for intermediate-term effects).

2a. At the 99.9<sup>th</sup> percentile of exposure, risk estimates for the maximum (90-day) seasonal exposures of infants to chlorotriazine residues in drinking water exceed HED's level of concern, i.e., are greater than 100% of the PAD for intermediate-term and chronic effects, in 26 of the 28 CWS analyzed. Of these 26 CWS, 22 serve approximately 128,000 people. (The Shipman reservoir has been excluded as it is no longer serving as a source of drinking water). The population served by the remaining 3 CWS was unavailable. See Appendix I, Table 1.

2b. At the 99<sup>th</sup> percentile of exposure, risk estimates for maximum (90-day) seasonal exposures of infants to chlorotriazine residues in drinking water exceed HED's level of concern in 12 of the 28 CWS analyzed. Of these 12 CWS, 8 serve approximately 34,000 people. (The Shipman reservoir has been excluded as it is no longer serving as a source of drinking water). The population served by the remaining 3 CWS was unavailable. Risk estimates for 4 CWS equal 100% of the PAD for intermediate-term effects. See Appendix II, Table 2.

2c. At the 95<sup>th</sup> percentile of exposure, risk estimates for peak seasonal exposures of infants to chlorotriazine residues in drinking water exceed HED's level of concern in 2 of the 28 CWS analyzed. Of these 2 CWS, 1 serves approximately 250 people, the other (Shipman reservoir) has been excluded as it is no longer serving as a source of drinking water. See Appendix III, Table 3.

3. Risk estimates for children are less than 100% of the PAD (below HED's level of concern) for intermediate-term effects for all CWS analyzed at the 99<sup>th</sup> percentile of exposure. Risk estimates for adults are less than 100% of the PAD for intermediate-term effects for all CWS analyzed at the 99.9<sup>th</sup> percentile of exposure.

4. A comparison of different models used to assess exposure to chlorotriazines in drinking water probabilistically indicated that if the same data sets are used and the same methodologies applied to the data, both models provide a similar distribution of exposures. However, if the same data sets are used but different methodologies are applied to the data, the resulting exposures will be different. The methodology used by Syngenta did not incorporate as much variability and randomness as the method preferred by OPP, and likely resulted in less refined estimates of exposure to chlorotriazines in drinking water.

Probabilistic exposure assessments for five of the 28 CWS were conducted using a methodology implemented by Novigen, Inc. in consultation with OPP. The results of this assessment were compared to the results from Syngenta's assessment. Two of the 5 CWS assessed using the Novigen methodology resulted in risk estimates at the 99.9<sup>th</sup> percentile of exposure below HED's level of concern, while three had risk estimates above HED's level of concern. Using the Syngenta methodology, risk estimates for 4 of these 5 CWS were above HED's level of concern, and one was below.

## **RECOMMENDATIONS**

The methodology used by Syngenta to assess exposure to chlorotriazine residues in drinking water probabilistically results in more refined estimates of exposure and risk for the 28 CWS assessed. However, depending on which percentile of exposure is selected as the basis of the risk estimate, the improvement in the risk estimates is limited to only a few CWS. The registrant may want to reconsider the methodology used in the submitted assessment. HED recommends the assessment for the 28 CWS be conducted using the methodology currently approved/used by OPP for cumulative dietary exposure assessment. This is the preferred approach. Specifically, the exposure assessment should include: 1) rolling 90-day exposure periods using the entire 1993 to 2000 data set of chlorotriazine concentrations in finished drinking water for each CWS, 2) separate assessments for male and female adults, and 3) more recent consumption data from the USDA's Continuing Survey of Food Intake by Individuals (CSFII 1994 to 1996). The preferred methodology should allow sequential daily chlorotriazine concentration values for rolling 90-day periods to be randomly matched with daily consumption values that also vary daily over the rolling 90-day periods for an individual as per CSFII records. This approach to the assessment maximizes randomness and variability, and should result in the most refined estimates of exposure using the available data.

## **DETAILED CONSIDERATIONS**

The general approach to the registrant's submitted probabilistic exposure assessments for 28 CWS are detailed in this section. A separate probabilistic exposure assessment was conducted for each of the 28 CWS. The 24 CWS identified as high risk through HED's revised preliminary risk assessment (1/19/01) are included. Syngenta subsequently identified 4 additional CWS to assess.

### **Population Subgroups Considered:**

The submitted probabilistic exposure assessment considered infants (< 1 year old), children 1 to 6, children 7 to 12, adults 13 to 50 (males and females), and the general population. The specific population distribution for each CWS was based on the US Census (1990) for the specific county served by a given CWS. Each population distribution was weighted as to the number of individuals in a given age and sex group as defined by the census. For example, for the CWS serving Marion Co, IL, the 1990 census data indicated 47.5% females and 52.5% males in the county. Based on percentages, the number of individuals in the county per 1 year age group were then estimated, i.e., males and females < 1 year old, < 2 years old, < 3 years old, etc. In the assessment, drinking water consumption rates and food consumption patterns were not linked for an individual, and the assessment for adult males and females is combined.

### **Exposure Scenarios Considered/Risk Assessments Conducted:**

Exposures to chlorotriazine residues in food and drinking water in the identified 28 CWS were assessed for several exposure scenarios: acute (1-day) exposures, short-term (30-day/monthly

exposures), intermediate-term (90-day/quarterly exposures), and chronic (multi-year) exposures. The intermediate-term exposure scenario included 2 exposure periods, one period covering exposures during April to June, and a second period covering exposures during May to July.

#### Toxicological Endpoints Selected:

Syngenta included risk estimates for each population subgroup and exposure scenario. Syngenta selected the following no observed adverse effects levels (NOAELs) and an uncertainty factor of 1000 as the basis of their risk estimates for chlorotriazine residues in food and drinking water:

Table 1. Toxic Endpoints selected for Risk Assessments for Dietary Exposures to Chlorotriazines (Food + Water) by Syngenta Compared to HED's Endpoints				
Exposure Scenario/Endpoints	Acute (1-day)	Short-term (1 to 30 days)	Intermediate-term (30 days to 6 months)	Chronic (annual/long-term)
Syngenta's NOAEL (mg/kg/day)	10 (delayed ossification in fetuses & decreased body weight gain in adults)	13 (infants), 6.3 (children), 5.0 (adults)	<b>13 (prostatitis effects in infants), 6.3 (preputial separation effects in children), 5.0 (attenuation of the LH surge in adults)</b>	1.8 (attenuation of pre-ovulatory LH* surge)
HED's NOAEL (mg/kg/day)	10 (delayed ossification in fetuses & decreased body weight gain in adults)	N/A**	<b>1.8 (attenuation of pre-ovulatory LH* surge)</b>	1.8 (attenuation of pre-ovulatory LH* surge)

\* Lutenizing hormone. \*\* HED did not conduct a risk assessment exclusively specific to short-term dietary exposures

HED notes that Syngenta's selection of endpoints and NOAELs for intermediate-term exposures differs from that selected by the HED's Hazard Identification Assessment Review Committee (HIARC memorandum dated April 5, 2002). Specifically, Syngenta selected a NOAEL of 13 mg/kg/day for prostatitis effects in the male Wistar rat (offspring) after the mothers were dosed 1 to 4 days post-natally as the basis of short-, and intermediate-term risk assessments on infants. HED considers this a short-term effect (relevant to effects seen within 1 to 30 days of dosing) as it is believed to occur after 1 to 4 days of post-natal maternal dosing. HED does not consider this an intermediate-term effect as used by the registrant in their probabilistic risk assessment. HED selected a NOAEL of 10 mg/kg/day based on the weight-of-evidence from 4 studies investigating developmental effects as the basis of risk assessments on infants and children for short-term exposures.

Syngenta selected a NOAEL of 6.3 mg/kg/day for short-, and intermediate-term risk assessments involving children. HED considers this a short-term effect (relevant to effects seen within 1 to 30 days of dosing) as it is believed to occur after 1 to 4 days of post-natal maternal dosing. HED does not consider this an intermediate-term effect as used by the registrant in their probabilistic risk assessment.

Finally Syngenta selected a NOAEL of 5.0 mg/kg/day as the basis of short-, and intermediate-term risk assessments on adults. This is from a study in which dosing occurred over 30 days.

HED does not consider this an intermediate-term effect as used by the registrant in their probabilistic risk assessment. HED selected a NOAEL of 1.8 mg/kg/day for use in intermediate-term risk assessments. This endpoint is from a 6-month subchronic study in which the LH surge was depressed after 4 to 5 months of dosing. Depression of the LH surge is dose and time dependent. HED selected this endpoint for use in intermediate-term (30 days to 6 months) and chronic (6 months to lifetime). This six-month study is considered adequate for use in selecting a chronic endpoint without an additional safety factor being added to account for study duration of less than 12 months. A LH surge study of longer duration may be of limited value given that the attenuation of LH surge occurs in normally aging Sprague-Dawley rats around 9 months of age. Though this endpoint (LH surge attenuation and estrous cycle disruption) is applicable only to females 13-50, HED's HIARC noted that this dose is the lowest NOAEL available in the toxicology database (i.e., the most sensitive endpoint), and therefore would be protective of other adverse effects, including those occurring in males, infants and children. Further, the attenuation of the LH surge is considered a biomarker indicative of atrazine's ability to alter hypothalamic-pituitary function in general. Therefore, a separate endpoint was not selected for other populations (i.e., males, infants and children).

Syngenta's selection of an uncertainty factor of 1000 is in agreement with that selected by HED's HIARC and Food Quality Protection Act Committee.

#### Drinking Water Exposures:

The probabilistic exposure assessments included estimates of average daily chlorotriazine concentration for the acute risk assessment, estimates of the monthly average daily concentration for the short-term risk assessment, estimates of the quarterly average daily concentration for the intermediate-term risk assessment, and an estimate of the multi-year average concentration for the chronic risk assessment.

Table 2. Exposure Scenarios Considered	
Exposure Scenario	Chlorotriazine Concentration in Finished Drinking Water
Acute (1-day)	Daily average concentration <sup>1</sup>
Short-term (30 days)	Monthly average daily concentration
<b>Intermediate-term (90 days April to July)</b>	<b>Quarterly average daily concentration</b>
<b>Intermediate-term (90 days May to August)</b>	<b>Quarterly average daily concentration</b>
Chronic (lifetime)	Multi-year average concentration

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<sup>1</sup> In other words, some CWS were included in monitoring under the PLEX, ARP, and VMS programs. In that case, when the same CWS had monitoring data for the same day under each or any two of these programs, an average daily concentration value was calculated for that day.

For each of the 28 CWS identified, chlorotriazine residues in finished drinking water specific to that CWS were compiled from three data sets: the Voluntary Monitoring Program sponsored by the registrant, data collected under the Safe Drinking Water Act (SDWA), and the Acetochlor Registration Partnership (ARP). Data from these three data sets were pooled for each of the 28 CWS. However, data were not combined across CWS, and averages or pooling occurred only when multiple measurements taken under different monitoring programs were available for the same CWS. Under each of these monitoring programs, samples of finished drinking water were taken and analyzed for atrazine, *per se*. Concentrations of the chlorotriazine metabolites for each CWS were estimated as discussed previously in Attachment VII to HED's revised preliminary risk assessment. Samples of finished drinking water were collected across these monitoring programs during the period from 1993 to 2000.

Data collected from 1993 to 2000 were organized by exposure period, i.e., consecutive, non-over-lapping 30-day (monthly) periods, or 90-day (quarterly) periods, and average concentrations for the time period were determined. For example, for the intermediate-term exposure assessments, data were organized by quarters (Jan/Mar, Apr/Jun, Jul/Sep, and Oct/Dec), and the 90-day (quarterly) average concentration (ug/kg/day) for each quarter was determined. This resulted in a distribution of approximately 28 point estimates of quarterly average chlorotriazine concentrations from 1993 to 2000 (4 quarterly averages per year x 7 years) used in the assessment.

Drinking water consumption rates (ml/kg/day) included in the registrant's exposure assessments were based on data collected under the USDA's Continuing Survey of Food Intake by Individuals (CSFII). The consumption rates used for adults are based on data from the CSFII 1977-1978, and broken down into the following age subgroups: adults 20 to 44, 45 to 64, 65 to 74, and 75 + years old. The consumption rates used for children are based on the CSFII data from 1989-1992, and broken down into the following age subgroups: infants (< 1 year old), children (1- 10 years old), and adolescents (11 to 19 years old). Consumption rates for adults were taken from Table 3-7 of the USEPA's "Exposure Factors Handbook, Volume I" (August 1997), and consumption rates for infants and children were taken from Table 4-2 from the USEPA's "Estimated Per Capita Water Ingestion in the U.S." (April 2000). Consumption rates were combined for males and females for each age group assessed. This resulted in a distribution of drinking water consumption rates which included the 1<sup>st</sup>, 5<sup>th</sup>, 10<sup>th</sup>, 25<sup>th</sup>, 50<sup>th</sup>, 75<sup>th</sup>, 90<sup>th</sup>, 95<sup>th</sup>, and 99<sup>th</sup> consumption percentiles for each of these age groups (given below in table 3). It is not clear if only this portion of the consumption distribution for water was used or the entire distribution.

Table 3. Drinking Water Consumption Rates									
Age (years)	Percentiles of Water Intake (ml/kg/day)								
	1%	5%	10%	25%	50%	75%	90%	95%	99%
<1	0	0	0	16	57	101	156	170	218
1 - 10	0	4	6	12	21	33	49	64	98

Table 3. Drinking Water Consumption Rates									
Age (years)	Percentiles of Water Intake (ml/kg/day)								
	1%	5%	10%	25%	50%	75%	90%	95%	99%
11 - 19	0	2	4	7	13	20	30	39	64
20 - 44	1.6	4.9	7.1	11.2	16.8	23.7	32.2	38.4	53.4
45 - 64	4.4	8.0	10.3	14.7	20.2	27.2	35.5	42.1	57.8
65 -74	4.6	8.7	10.9	15.1	20.2	27.2	35.2	40.6	51.6
75+	3.8	8.8	10.7	15.0	20.5	27.1	33.9	38.6	47.2

#### Food Exposure:

The assessment included average daily food exposure (mg/kg/day) to the chlorotriazines through food as a point estimate. That is, the assessments assume that an individual within a specific age/sex population subgroup receives the same daily (constant) exposure to chlorotriazines in food during the exposure period assessed. Point estimates of dietary exposure were taken from HED's chronic dietary assessment as given in Attachment V to HED's revised preliminary risk assessment. HED's dietary assessment included anticipated residue concentrations of chlorotriazines in foods combined with average dietary consumption of food and average body weights collected under the CSFII 1989-1992. The results of that chronic dietary assessment based on the Dietary Exposure Evaluation Model (DEEM™) for exposure to chlorotriazines in foods are given below in table 4:

Table 4. Chronic Dietary Exposure	
Population Subgroup	Average Daily Dietary Exposure (mg/kg/day)
Infants (< 1 year old)	0.000008
Children 1 to 6	0.000017
Children 7 to 12	0.000009
Females 13 to 50	0.000003
Males 13 to 19	0.000006
Males 19 to 50	0.000003
Seniors	0.000003

These point estimates of dietary exposure to the chlorotriazines represent an average, constant daily exposure, and not a 99.9th percentile dietary exposure as stated in the registrant's submitted report.

For the acute (1- day) exposure assessment, this approach combines a distribution of daily

chlorotriazine concentrations in drinking water with a point estimate of average daily chlorotriazine exposures in foods. For all other drinking water exposures considered, this approach combines a distribution of average monthly, quarterly, or lifetime exposure with a point estimate of average daily chlorotriazine exposures in foods. The registrant included a point estimate of  $4.5 \times 10^{-6}$  mg/kg/day for the average food exposures for adults, which is the average of the combined female food exposure with the average food exposure for the most highly exposed male population subgroup.

#### Combining Intermediate-term Drinking Water and Food Exposures Probabilistically:

In the intermediate-term drinking water exposure assessment, drinking water consumption rates and food consumption patterns were not linked for an individual. The registrant's assessment assumes the same daily drinking water consumption rate (a point estimate taken from a distribution of consumption rates as described in the table 3) for an individual (within a given age group) throughout the entire exposure period assessed. Consequently, a specific individual's drinking water consumption rate does not vary (is fixed) during the exposure assessment. For example, for the intermediate-term exposure assessments, if the consumption rate randomly selected for an individual from the distribution of rates is 16.8 ml/kg/day that consumption rate is assumed for that individual everyday during the 90-day exposure period.

Chlorotriazine concentrations (ug/kg/day) in drinking water are included in the intermediate-term assessment as a randomly selected quarterly average (a point estimate) from a distribution of quarterly averages. The quarterly (90-day) average chlorotriazine concentration is assumed to occur on a daily basis in the drinking water consumed by an individual throughout the entire 90-day exposure period.

An individual's drinking water exposure to chlorotriazine is estimated by multiplying the randomly selected drinking water consumption (ml/kg/day), which is fixed during the 90-day exposure period, by the randomly selected 90-day average chlorotriazine concentration (ug/kg/day), which is also fixed during the 90-day exposure period. Conversion factors are applied to obtain the results in mg/kg/day. Food exposure (mg/kg/day) is then added as a point estimate representing average food exposures for a specific age group from table 4 to the estimated drinking water exposure. Consumption rates and food exposures are specific to age population subgroups, as previously described, but not specific as to sex. The resulting distribution of exposures represents the average quarterly (90-day) exposure to chlorotriazines in food and drinking water for individuals representing the population at each CWS by specific population subgroups defined by age.

#### Results (Risk Estimates) for Intermediate-Term (Seasonal) Drinking Water and Food Exposure:

The results for the probabilistic assessment of intermediate-term (seasonal) exposures to the chlorotriazines in food and drinking water are discussed in this section. For the CWS assessed, the dominant exposure pathway for chlorotriazine residues is drinking water. Food exposures to chlorotriazines are insignificant (< 1% of the PAD for intermediate-term effects). Although

informative, probabilistic assessments of exposure for other exposure periods were not considered necessary and are not discussed in this memorandum, because risk estimates for these other durations of exposure assessed under HED's revised preliminary assessment did not exceed HED's level of concern.

To estimate risk, the distribution of dietary exposures (food + drinking water) to chlorotriazines are compared to a toxic reference dose or population adjusted dose (PAD) for intermediate-term effects. HED has selected 0.0018 mg/kg/day as the relevant toxic reference dose for chlorotriazine residues for comparison to intermediate-term dietary exposures (30 days to 6 months) to chlorotriazines. The 95<sup>th</sup>, 99<sup>th</sup>, and 99.9<sup>th</sup> percentiles of exposure for infants, children (1 to 6 years old) and adults (male and female combined) were taken from Syngenta's probabilistic exposure assessment for each of the 28 CWS and compared to this PAD.

At the 99.9<sup>th</sup> percentile of exposure, risk estimates for maximum (90-day) seasonal exposures of infants to chlorotriazine residues in drinking water exceed HED's level of concern, i.e., are greater than 100% of the PAD for intermediate-term effects, in 26 of the 28 CWS analyzed. Of these 26 CWS, 22 serve approximately 128,000 people. (The Shipman reservoir has been excluded as it is no longer serving as a source of drinking water). The population served by the remaining 3 CWS was unavailable. See Appendix I, Table 1.

At the 99<sup>th</sup> percentile of exposure, risk estimates for maximum (90-day) seasonal exposures of infants to chlorotriazine residues in drinking water exceed HED's level of concern in 12 of the 28 CWS analyzed. Of these 12 CWS, 8 serve approximately 34,000 people. (The Shipman reservoir has been excluded as it is no longer serving as a source of drinking water). The population served by the remaining 3 CWS was unavailable. Risk estimates for 4 CWS equal 100% of the PAD for intermediate-term effects. See Appendix II, Table 2.

At the 95<sup>th</sup> percentile of exposure, risk estimates for maximum (90-day) seasonal exposures of infants to chlorotriazine residues in drinking water exceed HED's level of concern in 2 of the 28 CWS analyzed. Of these 2 CWS, 1 serves approximately 250 people, the other (Shipman reservoir) has been excluded as it is no longer serving as a source of drinking water. See Appendix III, Table 3.

Risk estimates for children are less than 100% of the PAD (below HED's level of concern) for intermediate-term effects for all CWS analyzed at the 99<sup>th</sup> percentile of exposure. Risk estimates for adults are less than 100% of the PAD for intermediate-term effects for all CWS analyzed at the 99.9<sup>th</sup> percentile of exposure.

Appendices I- III contain the exposure and risk estimates for seasonal exposures to chlorotriazines in food and drinking water.

## Comparison of Methodologies Used to Probabilistically Assess Exposure:

Probabilistic exposure assessments for five of the 28 CWS were conducted using a methodology developed by Novigen, Inc. in consultation with OPP. The results of this assessment were compared to the results from Syngenta's assessment discussed above. Two of the 5 CWS assessed using the Novigen methodology resulted in risk estimates at the 99.9th percentile of exposure below 100% of the PAD, i.e., below HED's level of concern, while three had risk estimates greater than 100% of the PAD, i.e., above HED's level of concern. Using the Syngenta methodology, risk estimates for 4 of these 5 CWS were above HED's level of concern, and one was below. The differences in the methodologies are discussed below.

The Novigen methodology included the full distribution of drinking water consumption rates (ml/kg/day) as reported for each individual included in the 1994 to 1996 CSFII. In the Novigen approach, a daily consumption rate is randomly selected from this distribution for an individual. This distribution is age category specific. Therefore, an individual's water consumption rate varies from day to day within the exposure period of interest versus the fixed consumption rate used in the Syngenta assessment, which is constant during the exposure period of interest.

For each of the 5 CWS assessed, Novigen determined the specific period during which the maximum daily chlorotriazine concentrations occurred for each year of data, selected the year with the highest period of daily concentrations, and then used this as a truncated distribution representing the peak period of chlorotriazine concentrations for that CWS in the 7-year period for which data were available. This resulted in a truncated distribution consisting of daily concentration values covering a variable time period (spanning weeks to months) for a specific CWS. For example, one CWS had a peak period of concentrations spanning a 12 month period. For this CWS, the daily concentrations covering those 12 months were used as a truncated distribution. Another CWS had a peak period of concentrations spanning 2 months. For this CWS, the daily concentrations covering those 2 months were used as a truncated distribution. The Novigen assessment included chlorotriazine concentration data from raw and finished drinking water where available for a given CWS.

In Novigen's assessment, daily concentration values from these distributions representing the highest exposures for each CWS were randomly selected and combined with the randomly selected age-specific individual consumption rates from the CSFII. The average 90-day exposure is then calculated from the daily estimates of exposure over the 90-day period. The average food exposure is added in as a point estimate to the 90-day average drinking water exposures as per Syngenta's assessment. In Novigen's assessment an individual's water consumption rate and daily concentration value of chlorotriazines varies from day to day within the exposure period of interest versus the fixed consumption rate and fixed average concentration assumed during the exposure period of interest used in the Syngenta assessment.

## Raw Water versus Finished Water:

Syngenta included a probabilistic exposure assessment for the 20 CWS for which chlorotriazine concentration data were available in raw and finished drinking water. For each of these 20 CWS, all monitoring data on both raw (untreated) and finished (treated) water were combined. The results of this assessment indicate that combining daily concentration values on atrazine residues in raw and finished water had almost no effect on the resulting exposure assessment. Under this approach, 27 out of 28 CWS had atrazine levels exceeding HED's level of concern at the 99.9th percentile of exposure. Using only data on finished drinking water, 26 out of 28 CWS had atrazine residue levels exceeding HED's level of concern. An examination of the data indicate that concentrations of atrazine residues in raw water are similar to those in finished water at the upper end of the distribution. Appendix IV contains estimates of exposures and risks at the 99.9<sup>th</sup> percentile of exposure for the combined raw and finished water data sets.

## APPENDIX I

### Risk Estimates @ the 99.9th Percentile of Exposure for Seasonal Exposures to Atrazine in Food and Finished Drinking Water

Table 1.__ Risk Estimates for High Seasonal Exposures to Atrazine in Finished Drinking Water and Average Dietary Exposure @ the 99.9th Percentile of Exposure*						
Community Water System (City/State)	Infant's Exposure (mg/kg/day)	% cPAD	Children's Exposure (mg/kg/day)	% cPAD	Adult's Exposure (mg/kg/day)	% cPAD
<b>Chariton, IA</b>	0.0021	<b>117</b>	0.00086	48	0.0005	28
<b>Sorento, IL</b>	0.0019	<b>105</b>	0.00087	48	0.00049	27
<b>Flora, IL</b>	0.0021	<b>116</b>	0.00089	49	0.00055	30
<b>W. Salem, IL</b>	0.0026	<b>144</b>	0.0012	66	0.00063	35
<b>Farina, IL</b>	0.0028	<b>155</b>	0.001	55	0.00068	38
<b>White Hall, IL</b>	0.0033	<b>183</b>	0.0015	83	0.00078	43
<b>Carlinville, IL</b>	0.0018	<b>100</b>	0.00083	46	0.00042	23
<b>Gillespie, IL</b>	0.006	<b>333</b>	0.0025	<b>139</b>	0.0014	78
<b>Hettick, IL</b>	0.0062	<b>344</b>	0.0023	<b>128</b>	0.0015	83
<b>Shipman, IL</b>	0.0069	<b>383</b>	0.0029	<b>161</b>	0.0017	94
<b>Palmyra-Modesto, IL</b>	0.0043	<b>239</b>	0.0018	100	0.00096	53
<b>N. Otter Twp ADGPTV, IL</b>	0.0025	<b>139</b>	0.001	56	0.00061	34
<b>Kinmundy, IL</b>	0.0025	<b>139</b>	0.00094	52	0.00055	31
<b>Salem, IL</b>	0.0072	<b>400</b>	0.0031	<b>172</b>	0.0017	94
<b>Centralia, IL</b>	0.0024	<b>133</b>	0.0011	61	0.00058	32
<b>Hillsboro, IL</b>	0.0034	<b>189</b>	0.0013	72	0.00083	46
Wayne City, IL	0.0015	83	0.0006	33	0.00036	20
<b>Louisville, IL</b>	0.0032	<b>178</b>	0.0013	72	0.00074	41
<b>Holland, IN</b>	0.0036	<b>200</b>	0.0015	83	0.00083	46
<b>North Vernon, IN</b>	0.0027	<b>150</b>	0.001	56	0.00067	37
<b>Batesville, IN</b>	0.0033	<b>183</b>	0.0012	67	0.00078	43

Table 1. Risk Estimates for High Seasonal Exposures to Atrazine in Finished Drinking Water and Average Dietary Exposure @ the 99.9th Percentile of Exposure*						
Community Water System (City/State)	Infant's Exposure (mg/kg/day)	% cPAD	Children's Exposure (mg/kg/day)	% cPAD	Adult's Exposure (mg/kg/day)	% cPAD
<b>Scottsburg, IN</b>	0.0039	<b>217</b>	0.0016	89	0.00087	48
<b>Iberville, LA</b>	0.0028	<b>156</b>	0.0012	67	0.00061	34
<b>Higginsville, MO</b>	0.0043	<b>239</b>	0.0016	89	0.00094	52
<b>Bucklin, MO</b>	0.0029	<b>161</b>	0.0012	66.7	0.00072	40
<b>Vandalia, MO</b>	0.0024	<b>133</b>	0.001	56	0.00055	31
<b>Sardinia, OH</b>	0.0076	<b>422</b>	0.0029	<b>161</b>	0.0018	100
Newark, OH	0.0013	72	0.00058	32	0.00033	18

\* The exposure estimates include an average (point estimate) dietary exposure of  $8 \times 10^{-6}$  mg/kg/day for infants (< 1 year old),  $1.7 \times 10^{-5}$  for children (1 to 6 years old), and  $4.5 \times 10^{-6}$  for adults (males and females).

## APPENDIX II

### Risk Estimates @ the 99th Percentile of Exposure for Seasonal Exposures to Atrazine in Food and Finished Drinking Water

Table 2.__ Risk Estimates for High Seasonal Exposures to Atrazine in Finished Drinking Water and Average Dietary Exposure @ the 99th Percentile of Exposure*						
Community Water System (City/State)	Infant's Exposure (mg/kg/day)	% cPAD	Children's Exposure (mg/kg/day)	% cPAD	Adult's Exposure (mg/kg/day)	% cPAD
Chariton, IA	0.0013	72	0.00043	24	0.00029	16
Sorento, IL	0.0013	72	0.00049	27	0.00031	17
Flora, IL	0.0016	89	0.00056	31	0.00036	20
W. Salem, IL	0.0016	89	0.00061	34	0.00039	22
Farina, IL	0.0018	100	0.00064	36	0.0004	22
<b>White Hall, IL</b>	<b>0.0024</b>	<b>133</b>	0.00085	47	0.00053	29
Carlinville, IL	0.0012	67	0.00043	24	0.00027	15
<b>Gillespie, IL</b>	<b>0.0034</b>	<b>189</b>	0.0011	61	0.00085	47
<b>Hettick, IL</b>	<b>0.0039</b>	<b>217</b>	0.0015	83	0.00093	52
<b>Shipman, IL</b>	<b>0.0049</b>	<b>272</b>	0.0016	89	0.0011	61
<b>Palmyra-Modesto, IL</b>	<b>0.0029</b>	<b>161</b>	0.00099	55	0.0006	33
N. Otter Twp ADGPTV, IL	0.0018	100	0.0006	33	0.00036	20
Kinmundy, IL	0.0015	83	0.00052	29	0.00033	18
<b>Salem, IL</b>	<b>0.0049</b>	<b>272</b>	0.0016	89	0.00099	55
Centralia, IL	0.0017	94	0.0006	33	0.00038	21
Hillsboro, IL	0.0018	100	0.00063	35	0.0004	22
Wayne City, IL	0.0011	61	0.00037	21	0.00023	13
<b>Louisville, IL</b>	<b>0.0021</b>	<b>117</b>	0.00078	43	0.0005	28
<b>Holland, IN</b>	<b>0.0023</b>	<b>128</b>	0.00077	43	0.00048	27
North Vernon, IN	0.0016	89	0.0006	33	0.00039	22
<b>Batesville, IN</b>	<b>0.002</b>	<b>111</b>	0.00072	40	0.00046	26

Table 2. Risk Estimates for High Seasonal Exposures to Atrazine in Finished Drinking Water and Average Dietary Exposure @ the 99th Percentile of Exposure*						
Community Water System (City/State)	Infant's Exposure (mg/kg/day)	% cPAD	Children's Exposure (mg/kg/day)	% cPAD	Adult's Exposure (mg/kg/day)	% cPAD
<b>Scottsburg, IN</b>	<b>0.0021</b>	<b>117</b>	0.00073	41	0.00048	27
Iberville, LA	0.0018	100	0.00069	38	0.00041	23
<b>Higginsville, MO</b>	<b>0.0026</b>	<b>144</b>	0.00085	47	0.00057	32
Bucklin, MO	0.0018	100	0.00066	37	0.00042	23
Vandalia, MO	0.0014	78	0.00052	29	0.00032	18
<b>Sardinia, OH</b>	<b>0.0041</b>	<b>228</b>	0.0013	72	0.0011	61
Newark, OH	0.001	56	0.00034	19	0.00022	12

\* The exposure estimates include an average (point estimate) dietary exposure of  $8 \times 10^{-6}$  mg/kg/day for infants (< 1 year old),  $1.7 \times 10^{-5}$  for children (1 to 6 years old), and  $4.5 \times 10^{-6}$  for adults (males and females).

### APPENDIX III

#### Risk Estimates @ the 95th Percentile of Exposure for Seasonal Exposures to Atrazine in Food and Finished Drinking Water

Table 3.____ Risk Estimates for High Seasonal Exposures to Atrazine in Finished Drinking Water and Average Dietary Exposure @ the 95th Percentile of Exposure*						
Community Water System (City/State)	Infant's Exposure (mg/kg/day)	% cPAD	Children's Exposure (mg/kg/day)	% cPAD	Adult's Exposure (mg/kg/day)	% cPAD
Chariton, IA	0.0005	28	0.0002	11	0.00014	8
Sorento, IL	0.00078	43	0.00028	16	0.00019	11
Flora, IL	0.00076	42	0.00029	16	0.0002	11
W. Salem, IL	0.00093	52	0.00034	19	0.00022	12
Farina, IL	0.00098	54	0.00037	21	0.00023	13
White Hall, IL	0.0012	67	0.00043	24	0.0003	17
Carlinville, IL	0.00065	36	0.00023	13	0.00015	8
Gillespie, IL	0.00092	51	0.00037	21	0.00026	14
<b>Hettick, IL</b>	<b>0.0022</b>	<b>122</b>	0.00077	43	0.00052	29
<b>Shipman, IL</b>	<b>0.0021</b>	<b>117</b>	0.00076	42	0.00053	29
Palmyra-Modesto, IL	0.0014	78	0.0005	28	0.00034	19
N. Otter Twp ADGPTV, IL	0.0009	50	0.00033	18	0.00021	12
Kinmundy, IL	0.00069	38	0.00026	14	0.00017	9
Salem, IL	0.0013	72	0.00054	30	0.0004	22
Centralia, IL	0.00088	49	0.00033	18	0.00022	12
Hillsboro, IL	0.0007	39	0.00027	15	0.00018	10
Wayne City, IL	0.00045	25	0.00018	10	0.00012	7
Louisville, IL	0.0012	67	0.00042	23	0.00029	16
Holland, IN	0.00093	52	0.00034	19	0.00024	13
North Vernon, IN	0.00077	43	0.00029	16	0.00019	11
Batesville, IN	0.00094	52	0.00034	19	0.00023	13

Table 3.____ Risk Estimates for High Seasonal Exposures to Atrazine in Finished Drinking Water and Average Dietary Exposure @ the 95th Percentile of Exposure*						
Community Water System (City/State)	Infant's Exposure (mg/kg/day)	% cPAD	Children's Exposure (mg/kg/day)	% cPAD	Adult's Exposure (mg/kg/day)	% cPAD
Scottsburg, IN	0.00082	46	0.0003	17	0.00022	12
Iberville, LA	0.00091	51	0.00034	19	0.00022	12
Higginsville, MO	0.00076	42	0.0003	17	0.00022	12
Bucklin, MO	0.00058	32	0.00025	14	0.00018	10
Vandalia, MO	0.00073	41	0.00026	14	0.00018	10
Sardinia, OH	0.00068	38	0.00029	16	0.00022	12
Newark, OH	0.00051	28	0.0002	11	0.00012	7

\* The exposure estimates include an average (point estimate) dietary exposure of  $8 \times 10^{-6}$  mg/kg/day for infants (< 1 year old),  $1.7 \times 10^{-5}$  for children (1 to 6 years old), and  $4.5 \times 10^{-6}$  for adults (males and females).

## APPENDIX IV

### Risk Estimates for Seasonal Exposures to Atrazine in Food and Finished and Raw Drinking Water

Table 4.____ Risk Estimates for High Seasonal Exposures to Atrazine in Finished and Raw Drinking Water and Average Dietary Exposure @ the 99.9th Percentile of Exposure*						
Community Water System (City/State)	Infant's Exposure (mg/kg/day)	% cPAD	Children's Exposure (mg/kg/day)	% cPAD	Adult's Exposure (mg/kg/day)	% cPAD
Chariton, IA	0.0021	117	0.00086	48	0.0005	28
Sorento, IL	0.0019	105	0.00084	47	0.00049	27
Flora, IL	0.0021	117	0.00089	49	0.00055	30
W. Salem, IL	0.0026	144	0.0012	67	0.00063	35
Farina, IL	0.0028	155	0.001	55	0.00068	38
White Hall, IL	0.0033	183	0.0015	83	0.00078	43
Carlinville, IL	0.0028	155	0.0012	67	0.00066	37
Gillespie, IL	0.006	333	0.0025	139	0.0014	78
Hettick, IL	0.0062	344	0.0023	128	0.0015	83
Shipman, IL	0.0069	383	0.0029	161	0.0017	94
Palmyra-Modesto, IL	0.0043	239	0.0018	100	0.00097	54
N. Otter Twp ADGPTV, IL	0.0026	144	0.0011	61	0.00063	35
Kinmundy, IL	0.0025	139	0.00094	52	0.00055	30
Salem, IL	0.0072	400	0.0031	172	0.0017	94
Centralia, IL	0.0031	172	0.0015	83	0.00075	42
Hillsboro, IL	0.0031	172	0.0013	72	0.00077	43
Wayne City, IL	0.0026	144	0.00099	55	0.00057	32
Louisville, IL	0.0032	178	0.0013	72	0.00074	41
Holland, IN	0.0036	200	0.0015	83	0.00083	46
North Vernon, IN	0.0027	150	0.001	55	0.00067	37
Batesville, IN	0.0033	183	0.0012	67	0.00078	43
Scottsburg, IN	0.0039	217	0.0016	89	0.00087	48

Table 4.____ Risk Estimates for High Seasonal Exposures to Atrazine in Finished and Raw Drinking Water and Average Dietary Exposure @ the 99.9th Percentile of Exposure*						
Community Water System (City/State)	Infant's Exposure (mg/kg/day)	% cPAD	Children's Exposure (mg/kg/day)	% cPAD	Adult's Exposure (mg/kg/day)	% cPAD
Iberville, LA	0.0028	155	0.0012	67	0.00062	34
Higginsville, MO	0.0043	239	0.0016	89	0.00094	52
Bucklin, MO	0.0029	161	0.0012	67	0.00072	40
Vandalia, MO	0.0028	155	0.0012	67	0.00073	40
Sardinia, OH	0.0075	417	0.003	167	0.0018	100
Newark, OH	0.0013	72	0.00058	32	0.00033	18

\* The exposure estimates include an average (point estimate) dietary exposure of  $8 \times 10^{-6}$  mg/kg/day for infants (< 1 year old),  $1.7 \times 10^{-5}$  for children (1 to 6 years old), and  $4.5 \times 10^{-6}$  for adults (males and females).